I. C. 6532

OCTOBER, 1931

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

METHODS AND COSTS OF CONCENTRATING TUNGSTEN ORES AT ATOLIA, SAN BERNARDINO COUNTY, CALIF.

RECEIVED
NOV 11 1931
O. S. U. LIBRARY

BY

W. O. VANDERBURG

Generated on 2024-09-17 10:07 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

Original from
THE OHIO STATE UNIVERSITY

I.C.6532.
October, 1931.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

METHODS AND COSTS OF CONCENTRATING TUNGSTEN ORES AT ATOLIA, SAN BERNARDINO COUNTY, CALIF.[1]

By W. O. Vanderburg[2]

INTRODUCTION

This paper describing the methods of concentrating tungsten ores at the mills of the Atolia Mining Co. is one of a series of similar papers being prepared by the United States Bureau of Mines.

The writer acknowledges the assistance and cooperation of A. V. Udell, president, Louis Warnken, bookkeeper, and C. K. Dennis, superintendent, of the Atolia Mining Co. in the preparation of this paper.

The Atolia district is in the western part of San Bernardino County near its boundary with Kern County, Calif. The district lies in the northern part of the Mohave desert, 40 miles east of the town of Mohave and 23 miles north of Kramer. The latter is a station on the Atchison, Topeka and Santa Fe Railroad and it is the southern terminus of a branch line to Johannesburg via Atolia. Train service over the branch railroad at present is weekly. The district is also accessible from Mohave by automobile stage which is operated on a daily schedule.

The Atolia Mining Co. owns two concentrators; one of the mills is used for concentrating scheelite obtained from placer operations, and the other for treating scheelite ore mined underground from fissure veins. The capacity of the placer concentrator is about 500 tons per day when operated in two shifts of 8 hours each. The Union mill for treating the ore derived from underground mining operations has a maximum capacity of 100 tons per day when operated in three shifts of 8 hours each. Both mills employ gravity concentration methods. At this time, January, 1931, only the placer concentrator is being operated.

Electric power is purchased from the Southern Sierras Power Co. at a rate of about 2 cents per kilowatt-hour. The power is transmitted from the hydroelectric plants in the Sierra Nevada to the Randsburg substation at 22,000 volts, and from Randsburg to Atolia, a distance of 4 miles, it is transmitted at 2,200 volts. For use in the mine and mills it is stepped down to 440, 220, or 110 volts.

Water for mill use is obtained from a well sunk to a depth of 200 feet in the valley 7 miles east of Atolia. This water is highly charged with chlorides and sulphates and is not fit for domestic use. As all-gravity methods of concentration are employed, the water is suitable for milling purposes. The water is pumped from the well to the mill storage tanks in two stages. From the well it is pumped through a 10-inch casing into a 5-inch riveted iron pipe line by a deep-well turbine; a relay centrifugal pump forces the water through the 5-inch pipe line into three redwood-stave mill storage tanks which have a combined capacity of 385,000 gallons. The lift from the well to the storage tanks is about 650 feet.

---

1 - The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular No. 6532."

2 - Associate mining engineer, U. S. Bureau of Mines.

Generated on 2024-09-17 10:02 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Water for domestic use is obtained from the 1,000-foot level of the Union mine. Before the above sources of water were developed both domestic and milling water were obtained from a number of wells in the vicinity and large amounts were shipped to Atolia in railroad tank cars from wells west of Kramer, 40 miles distant.

ORE TREATED

The placer scheelite occurs in alluvium which is mostly the size of coarse sand and gravel. The alluvium is composed largely of detrital material resulting from the disintegration of quartz monzonite, which is the principal rock of the district. The scheelite nuggets in the alluvium, which have been concentrated into numerous small channels by heavy rains, vary in size from sand particles to that of small potatoes, which are termed "spuds" by the miners. During the World War the larger nuggets were an important source of scheelite. Bowlders of almost pure scheelite weighing several hundred pounds each have been found but are of rare occurrence.

The area of placer ground worked up to the present time is about 1 mile long and about 1/2 mile wide. The depth of the alluvium varies from several feet to a maximum of 150 feet. The maximum depth which can be worked economically by present methods is about 30 feet, due to the existence of barren strata between the upper and lower channels of concentration. An important feature in the recovery of scheelite from placer operations is the fact that the material is loosely cemented so that blasting is not necessary in mining operations.

The ore mined underground, principally by shrinkage and open-stope methods, occurs in fissure veins in a country rock of quartz monzonite. The veins vary in width from several inches up to 5 feet, with occasional lenses of ore as wide as 20 feet. The scheelite occurs as crystals embedded in fine-grained quartz. The cleavage faces of the crystals vary from 1/8 to 1/4 inch in diameter, and in the high-grade ore the growth of the crystals close together has resulted in a crystalline aggregate of indefinite form and of almost pure scheelite.

The objectionable elements found in the mine ore from a marketing viewpoint are phosphorus and sulphur. The phosphorus is present as apatite and the sulphur as pyrite. Magnetite, locally termed "black sand," also occurs in the ore and in the uncleaned concentrates. The phosphorus, sulphur, and magnetite contents are reduced in the final concentrates by roasting and magnetic concentration.

The scheelite is very brittle and for this reason crushing of the ore, preliminary to concentration, is not finer than 1/8 to 1/4 inch, depending on the character and the grade of the ore. Finer crushing or grinding of Atolia ore results in the loss of a large percentage of scheelite in the slimes and an increase of impurities in the concentrates.

PRODUCTION

The value of the total production of scheelite concentrates from the Atolia district has amounted to approximately $13,000,000. A large portion of this amount was produced during the World War, when abnormally high prices prevailed.
The production record from the properties of the Atolia Mining Co. from 1909 to November 1, 1930, is given in the table which follows:

Generated on 2024-09-17 10:08 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Production record of the Atolia Mining Co. properties

Year	Ore mined, tons	Units of WO_3 produced per ton of ore	Average selling price per unit
1909	5,182	6.22	$5.83
1910	6,780	4.05	8.48
1911	4,856	3.48	6.37
1912	8,043	3.24	8.10
1913	7,592	4.06	7.98
1914	4,829	6.07	6.50
1915	8,994	6.00	14.03
1916	17,406	6.28	33.74
1917	22,064	4.81	18.54
1918	28,071	2.37	25.11
1919[1]	-	-	-
1924	665[2]	15.516	8.28
1925	8,492	3.111	9.45
1926	19,360	1.027	12.60
1927	18,160	0.880	10.80
1928	78,934	0.222	10.52
1929	161,943	0.075	11.66
1930[3]	106,122	-	-

1 - Properties idle from 1919 to 1923.
2 - Lease ore.
3 - Ten months.

BRIEF HISTORY

During the early days of gold mining in the vicinity of Randsburg, which was discovered in 1897, a heavy white mineral interfered with the concentration of the gold. This mineral was identified as scheelite in 1903, and the location or claims followed. A subsequent consolidation of these claims developed into the Atolia Mining Co., which was organized in 1906.

Prior to the World War the importance of the Atolia district as a producer of tungsten was small, as the prevailing price per unit of WO_3 was insufficient to arouse interest. When the Allies began to organize their munitions departments on an extensive scale, large quantities of high-speed steel for cutting tools were required, and the use of tungsten in alloy steels increased greatly. The price increased from around $7.50 per unit of 20 pounds of tunstic acid content to as high as $80 per unit. Intense activity prevailed in the Atolia district, and a mill for the concentration of mine ore was built. This mill had capacity for the treatment of 75 tons of ore per day. The method of concentration was briefly as follows: Crushing and grinding was done in a Blake-type crusher followed by two Huntington mills and a Marcy ball mill. The ball-mill discharge was deslimed by a Dorr duplex classifier; Callow cones were used for thickening the slime pulp. Concentration was effected by Deister tables. Tailings were dewatered in an Oliver continuous filter, and the filter cake was transported to the tailings pile by belt conveyer. The slime tailings were impounded in a separate pond for future treatment.

With the fine grinding of the ore as practiced in this flow sheet, a large amount of the scheelite was lost in the slimes. The slime tailings produced in this first mill amount to approximately 75,000 tons and contain about 1.5 per cent of tungstic acid. Experimental work

Generated on 2024-09-17 10:11 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

for the recovery of the scheelite in these slime tailings by flotation methods is being done, and the results so far are encouraging.

From 1919 to 1923 the mines of the district were closed down, as the accumulated stocks of tungsten concentrates which were thrown on the market after the war sufficed to meet the peace-time requirements for the metal for a number of years. The Atolia mines were able to resume operations in 1923 because of a tariff passed in September, 1922. The 1923 tungsten tariff amounted to $7.43 per unit of 20 pounds of WO_3, and in 1929 this was increased to $7.93 per unit.

The mill for concentrating the placer ore was built in 1926, and the present mill for the treatment of mine ore, called the Union mill, was constructed in 1928.

TREATMENT OF PLACER ORE

The concentrator for the treatment of placer ore occupies a comparatively level site, and consequently the ore must be elevated for treatment. The scheelite concentrates produced per ton of placer material average a little over 1 1/2 pounds, so that the treatment of this material must of necessity be very simple. The unique feature of the concentrator is the large amount of material handled compared to the size of the plant. The maximum capacity of the mill when operating on a 3-shift basis is about 800 tons and the entire floor area of the plant occupies about 1,600 square feet. A crew of 16 men is required to handle about 500 tons per day. The direct cost of mining and concentrating the placer ore for the first 10 months of 1930 was 37 cents per ton.

The flow sheet of the placer-ore concentrator is shown in Figure 1.

Mining

The alluvium in which the scheelite occurs is mined with a revolving-type shovel mounted on caterpillars. The dipper has a capacity of 1 ton and is equipped with manganese-steel teeth to which stellite tips are welded. Two trucks with capacities of 7 3/4 and 5 1/4 tons, respectively, are employed to haul the placer ore from the shovel to the dumping platform, a distance which averages about 1,000 feet. The trucks are driven up an incline to the dumping platform, where the ore is discharged onto a grizzly with 6-inch openings placed over the top of a bin. The oversize material is broken by hand sledges.

Screening

From the bin the ore passes to an inclined conveyor belt which carries it to a disintegrator. Referring to Figure 2, this disintegrator is composed of a trommel screen and a number of hammers mounted on a shaft which is independent of the trommel. The trommel revolves counter to the shaft to which the hammers are attached, and the oversize material is broken by the hammers to pass through the trommel openings. The trommel is 4 feet in diameter by 8 feet long and is made of 5/8-inch steel plate with 2-inch round perforations. It is mounted horizontally on two sets of rollers, one of which is equipped with chain-and-sprocket drive.

Twelve 16-pound manganese-steel hammers, each 3 inches square and 6 inches long, are attached to the shaft by chains and clamps. The clamps are held in position by bolts through the shaft. The steel shaft is 3 7/16 inches in diameter. The hammers revolve at a speed of 50 r.p.m. The loosely cemented gravel and the partially disintegrated quartz monzonite are easily broken by this machine.

Generated on 2024-09-17 10:07 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Generated on 2024-09-17 10:05 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google

Digitized by Google

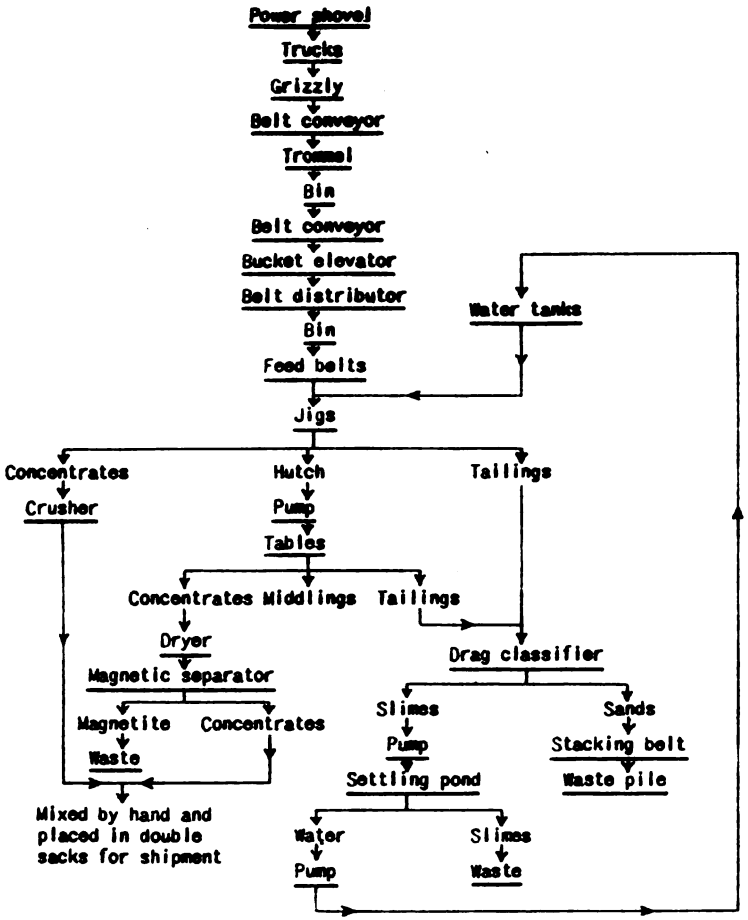

Figure 1.- Flow sheet for treatment of placer ore

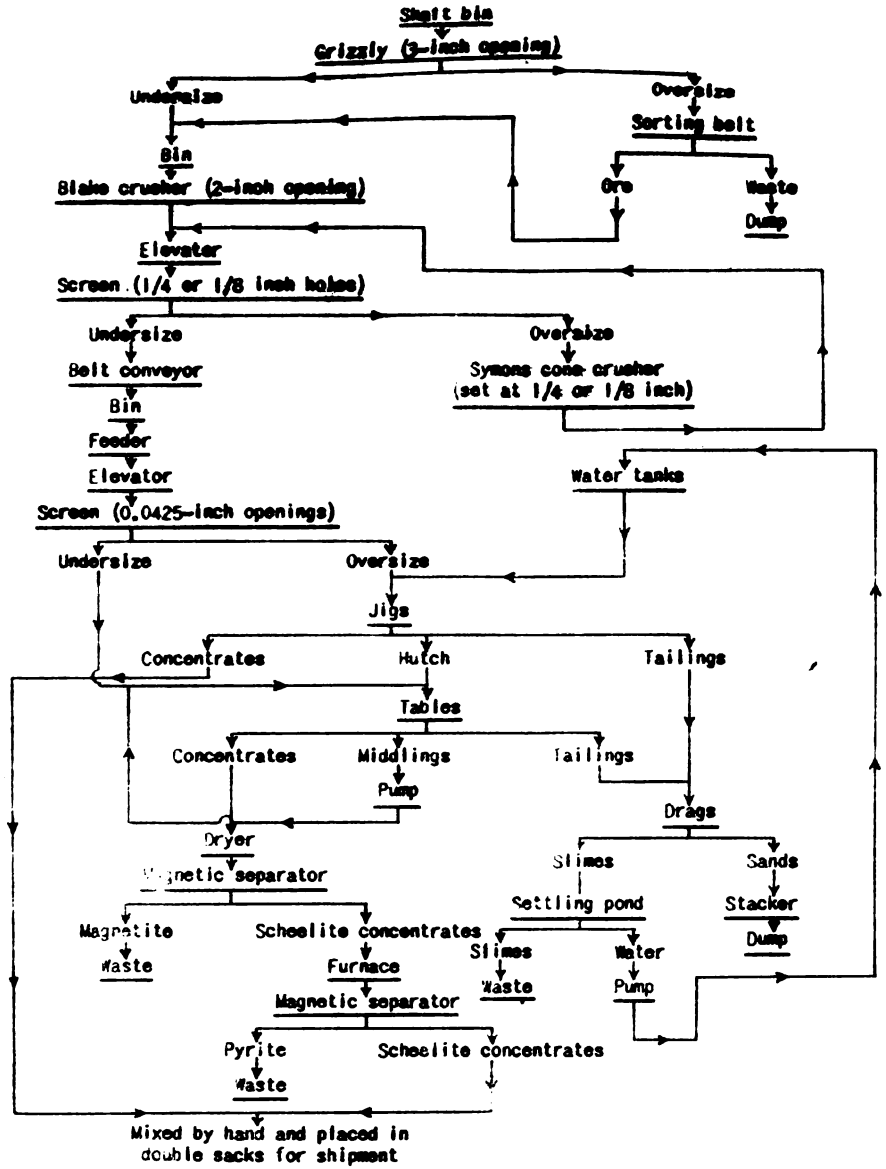

Figure 4.- Flow sheet for treatment of mine ore

Original from THE OHIO STATE UNIVERSITY

The screen undersize material falls by gravity into a 400-ton capacity wooden bin. From this bin the ore is transported by conveyor belt and bucket elevator to the mill storage bins, which have a combined capacity of 250 tons.

Jigging and Tabling

From the mill bins the ore is fed to four 2-compartment Harz-type jigs by hopper feeders and feed belts; one belt serves each jig. The jigs are equipped with 25 by 34 inch sieves which have 0.03-inch openings. The plungers are operated with a 5/8-inch stroke and at speed of 150 strokes per minute. The height of bed is about 10 inches.

The jigs produce three products; namely, concentrates, hutch, and tailings. The concentrates are usually removed from the jigs by hand skimming at the end of every two shifts. The hutch products, which comprise approximately 25 per cent of the mill feed, are collected in a common sump and from here are pumped to either of two Overstrom concentrating tables for additional cleaning. The tables produce concentrates, middlings, and tailings. The table concentrates which contain large amounts of magnetite or so called "black sands" are collected each day and sent to a magnetic separator for the removal of the "black sands." The table middlings are returned to the tables and the table tailings join the jig tailings for dewatering in drag classifiers.

Magnetic Separation and Sacking of Concentrates

The table concentrates are dried on a wood-fired oven and shoveled into a hopper which feeds the magnetic separator. The separator is a 4-pole Wetherill machine equipped with a roll feeder. The magnets are wound for 30,000 and 60,000 ampere turns, respectively. The voltage employed is 120, and the current for the first pair of poles is 1.5 amperes and for the second pair 6.0 amperes. Cross-conveyor belts are used to carry the magnetic material out of the magnetic field. The cross-conveyor belts are made of used inner tubes from high-pressure automobile tires. The scheelite is discharged from the separator into a wheelbarrow.

The jig concentrates are crushed to 3/4-inch size in a laboratory Blake-type crusher, after which the jig and cleaned table concentrates are mixed by hand and sacked in double burlap and canvas sacks for shipment. The placer concentrates contain approximately 62 per cent of tungstic acid and 0.010 per cent of phosphorus. The amount of sulphur in this product is negligible.

Dewatering and Disposal of Tailings

As previously mentioned, the jig and table tailings join for dewatering in drag classifiers. Referring to Figure 3, the classifiers are equipped with drags made of 3 1/4-inch angle irons 16 inches long bolted to 5-ply rubber-surfaced belts 16 inches wide. The angles are spaced 6 inches apart. Each drag is driven at a speed of 30 f.p.m. by chain-and-sprocket drive connected to the head pulley. The launder in which the drag operates is 12 by 24 inches in cross section, is made of 2-inch planks, and has a slope of 5 inches per foot.

The dewatered tailings are carried by conveyor and stacking belts to the waste dump.

The overflow products from the drag classifiers go to sumps and from there are pumped to the head of a settling pond. Clear water is reclaimed from this pond and is returned to the mill water supply tanks by pumping.

The mined-out placer channels are utilized for settling ponds, and when one is full another is used. Ths sides of the settling ponds are built up by means of the power shovel.

Generated on 2024-09-17 10:01 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Recovery

The recovery of placer scheelite is estimated to be about 70 per cent. The losses in concentration are due to causes which follow: (a) Scheelite mechanically locked with quartz, (b) scheelite intermixed with placer gravel which has not been disintegrated, and (c) scheelite in slimes which can not be recovered by tables.

TREATMENT OF MINE ORE

General

At the present time, January, 1931, the Union concentrator, erected for the treatment mine of ore, is not operating due to the low price of tungsten concentrates. This concentrator was last operated in 1929 for the treatment of low-grade dump ore which contained about 6 pounds of scheelite per ton. When operating on mine ore the treatment is practically the same as that of the dump material, except that mine ore is crushed to 1/8-inch as compared to 1/4-inch size for dump material prior to concentration. The flow sheet of the Union concentrator is shown in Figure 4.

When the concentrator operates on dump ore the material is hauled to the shaft pocket on the surface and hoisted from the shaft pocket to the shaft ore bin, a distance of about 80 feet. In 1929, the loading and hauling from the dumps were done on contract at an average rate of 38 cents per ton.

Sorting

From the shaft bin the ore passes to a revolving disk grizzly 2 1/2 feet in diameter, having 3-inch spaces. The oversize passes onto a sorting belt from which pieces of ore are picked off by a sorter and dropped into a bin with the grizzly undersize. The waste rejected at the sorting belt comprises about 25 per cent of the dump material.

Crushing

From the storage bin, the grizzly undersize and the sorted ore are fed by gravity to a 10 by 16 inch Blake-type crusher equipped with corrugated manganese-steel wearing plates. The crushed product, minus 2-inch size, is conveyed by belt and elevator to an inclined vibratory screen having 1/4-inch openings. The oversize of the screen is discharged directly into a 3-foot Symons cone crusher set to crush to 1/4-inch size. The crusher product is returned to the elevator which feeds the vibratory screen. The screen undersize product, minus 1/4-inch size, is conveyed by a belt to the fine-ore bin.

Screening

The fine-ore bin delivers feed to the mill at a uniform rate by means of a reciprocating type feeder. The feeder discharges the material to a bucket elevator which feeds a stationary inclined screen, 2 feet wide and 5 feet long. The oversize, plus 0.0425-inch, is concentrated by jigs and the undersize by tables.

Jigging

A Traylor 2-compartment fixed sieve jig is used for the concentration of the coarser scheelite. The jig screens are 17 1/2 by 27 inches in size and are equipped with 0.045-inch

Generated on 2024-09-17 10:02 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

openings. The concentrates are removed from the jig bed by hand skimming. The hutch joins the inclined screen undersize product and flows by gravity to either of two concentrating tables. The jig tailings are conveyed by launder to the dewatering drag classifiers.

Tabling

Two Overstrom single-deck tables are used for the concentration of the scheelite contained in the sand products. The table middlings are returned by pump to the tables, and the tailings are conveyed to the dewatering drag classifiers. The tables recover about 90 per cent of the total scheelite produced, and the table concentrates have the following analysis:

	Per cent
WO_3	40.0
S	8.0
P	0.15

The sulphur and phosphorus occur in pyrite and apatite, respectively. The concentrates also contain magnetite.

Magnetic Separation and Roasting

The table concentrates, after drying, are fed to a Wetherill magnetic separator for the removal of the magnetite. The scheelite product is then roasted in an 8-hearth oil-fired Herreshoff furnace, 3 feet in diameter and 6 feet high. The pyrite is changed to a magnetic product, and the apatite decrepitates during the roasting operation, which results in approximately 75 per cent of the phosphorus being removed in the furnace dust. The roasted concentrates are again treated by the Wetherill separator for the removal of the magnetic pyritic material. The jig and cleaned table concentrates are mixed by hand and sacked in double canvas and burlap sacks for shipment. Each sack holds about 120 pounds of concentrates. The analysis of one carload shipment follows:

	Per cent
WO_3	66.58
Sulphur	0.16
Phosphorus	0.034
Arsenic	0.007
Tin	None
Copper	Trace

Dewatering

The dewatering drag used at the Union concentrator is of the same design as that described in the placer ore mill. The coarse material is conveyed to the waste dump by a stacker belt, and the slimes are conveyed by launder to an earth-wall settling pond. The reclaimed water is returned by pump from the settling pond to the mill storage tanks.

Generated on 2024-09-17 10:03 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Recovery

The recovery of scheelite from dump material is estimated to be about 80 per cent. The tailings contain about 1 pound of scheelite per ton. The loss of scheelite in the tailings is partly due to included grains and partly due to slimed scheelite which is not readily recovered by gravity methods of concentrating.

SAMPLING AND ASSAYING

Analytical methods are not employed for mill-control purposes. The specific gravity of scheelite is high in comparison with the associated gangue minerals, so that close estimates can be made by means of gravity separation with a pan.

The tungstic acid content of concentrates is determined by a specific-gravity method. This method is accurate to within 2 per cent on Atolia concentrates, as the gangue impurities are fairly uniform in specific gravity. The apparatus required comprises a 500 c.c. flask graduated in 5 c.c. units and a scale which weighs in grams and which has a capacity of at least 200 grams.

The operation consists in grinding a representative sample of concentrates to 10-mesh size. Water is poured into the graduated flask until the 400-c.c. mark is reached, after which a sample of concentrates weighing 200 grams is poured into the flask. The volume of the water and solids in the flask is then read and the tungstic acid content of the concentrates is calculated as follows:

Let T equal the combined volume of water and solids in cubic centimeters; then (T-400) equals the volume of water displaced by 200 grams of concentrates; and $\frac{200}{T-400}$ is the specific gravity of the concentrates.

The percentage of tungstic acid in the concentrates is then found in Table 1. The data in this table are based on the assumption that all gangue material has the specific gravity of quartz.

Concentrates are sold through a broker on analyses made by custom assayers.

METALLURGICAL DATA

Metallurgical data for the Placer concentrator for 10 months of 1930 are presented in Table 2.

Metallurgical data for the Union concentrator for 1929 are given in Table 3.

COSTS

A summary of costs for the Placer concentrator for 10 months of 1930 is presented in Table 4. Table 5 gives labor and power distributions for the same plant over the same period

A summary of costs for the Union concentrator for 1929 is given in Table 6. Table 7 presents labor and power distributions for the Union concentrator over the same period.

Generated on 2024-09-17 10:10 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Table 1.—Per cent of tungstic acid as indicated by specific gravity of Atolia scheelite ores[1]

Specific gravity	Per cent WO_3	Specific gravity	Per cent WO_3	Specific gravity	Per cent WO_3	Specific gravity	Per cent WO_3
3.00	15.40	4.77	61.80	5.19	68.00	5.60	73.20
3.10	18.40	4.78	62.00	5.20	68.10	5.61	73.30
3.20	21.20	4.79	62.00	5.21	68.20	5.62	73.40
3.30	24.50	4.80	62.10	5.22	68.40	5.63	73.50
3.40	28.00	4.81	62.20	5.23	68.50	5.64	73.60
3.50	31.20	4.82	62.40	5.24	68.60	5.65	73.70
3.60	34.00	4.83	62.80	5.25	68.70	5.66	73.80
3.70	37.00	4.84	63.00	5.26	69.00	5.67	73.90
3.80	39.60	4.85	63.20	5.27	69.10	5.68	74.00
3.90	42.20	4.86	63.30	5.28	69.20	5.69	74.10
4.00	44.80	4.87	63.40	5.29	69.40	5.70	74.20
4.10	47.30	4.88	63.60	5.30	69.60	5.71	74.32
4.20	49.60	4.89	63.70	5.31	69.70	5.72	74.44
4.30	51.60	4.90	63.80	5.32	69.80	5.73	74.56
4.40	54.00	4.91	64.10	5.33	70.00	5.74	74.68
4.50	56.20	4.92	64.20	5.34	70.10	5.75	74.80
4.51	56.40	4.93	64.30	5.35	70.20	5.76	74.92
4.52	56.70	4.94	64.40	5.36	70.40	5.77	75.04
4.53	57.00	4.95	64.50	5.37	70.60	5.78	75.16
4.54	57.30	4.96	64.70	5.38	70.70	5.79	75.28
4.55	57.50	4.97	64.80	5.39	70.80	5.80	75.40
4.56	57.60	4.98	65.00	5.40	71.00	5.81	75.54
4.57	57.80	4.99	65.20	5.41	71.10	5.82	75.68
4.58	58.00	5.00	65.40	5.42	71.20	5.83	75.82
4.59	58.20	5.01	65.50	5.43	71.30	5.84	75.96
4.60	58.40	5.02	65.60	5.44	71.40	5.85	76.10
4.61	58.60	5.03	65.80	5.45	71.50	5.86	76.24
4.62	59.00	5.04	66.00	5.46	71.60	5.87	76.38
4.63	59.20	5.05	66.10	5.47	71.70	5.88	76.52
4.64	59.30	5.06	66.30	5.48	71.80	5.89	76.66
4.65	59.50	5.07	66.40	5.49	71.90	5.90	76.80
4.66	59.80	5.08	66.60	5.50	72.00	5.91	76.94
4.67	60.00	5.09	66.80	5.51	72.10	5.92	77.08
4.68	60.10	5.10	66.90	5.52	72.24	5.93	77.22
4.69	60.20	5.11	67.00	5.53	72.36	5.94	77.36
4.70	60.40	5.12	67.10	5.54	72.48	5.95	77.50
4.71	60.60	5.13	67.20	5.55	72.60	5.96	77.64
4.72	60.70	5.14	67.30	5.56	72.72	5.97	77.78
4.73	61.00	5.15	67.60	5.57	72.84	5.98	77.92
4.74	61.20	5.16	67.70	5.58	72.96	5.99	78.06
4.75	61.40	5.17	67.80	5.59	73.08	6.00	78.20
4.76	61.60	5.18	67.90	-	-	-	-

1 - Compiled by Marshall D. Draper and F. H. Lershen, formerly of Atolia.

Generated on 2024-09-17 10:04 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Table 2.—Metallurgical data for the Placer concentrator for 10 months of 1930

Ore mined and milled	tons	106,122
Operating time	days	262
Average ore treated per day	tons	405
Concentrates produced	pounds	155,151
Average concentrates produced per ton of ore milled	pounds	1.46
Jigs:		
Concentrates produced by jigs	per cent of total	85
Operating time of jigs	do.	54.8
Average concentrates produced by jigs per day	pounds	592.2
Analyses of jig concentrates:		
WO_3	per cent	60
P	do.	0.010
Tables:		
Concentrates produced by tables	per cent of total	15
WO_3 in table concentrates	per cent	73
Concentration ratio	tons into 1	1,369
Net water used per ton of ore milled	gallons	150

Table 3.—Metallurgical data for the Union concentrator, 1929

Ore milled	tons	55,104
Operating time	days	316
Average ore treated per day	tons	151
Operating time of crushing department	hours per day	16
Operating time of milling department	do.	24
Concentrates produced	pounds	275,890
Average concentrates produced per day	do.	873.1
Average concentrates produced per ton of ore milled	do.	5.0
Jigs:		
Concentrates produced by jigs	per cent of total	10
Analyses of jig concentrates:		
WO_3	per cent	65
S	do.	0.02
P	do.	0.025
Tables:		
Concentrates produced by tables	per cent of total	90
Analyses of table concentrates:		
WO_3	per cent	40
S	do.	8.0
P	do.	0.15
Analyses of table concentrates after roasting and magnetic separation:		
WO_3	per cent	67
S	do.	0.5
P	do.	0.08
Concentration ratio	tons into 1	400
Net water used per ton of ore milled	gallons	150

Generated on 2024-09-17 10:09 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Table 4.—Summary of direct costs at the Placer concentrator for 10 months of 1930

	Dollars per ton of ore milled			
	Labor	Power	Supplies	Totals
Mining and trucking	0.040	-	0.060	0.100
Milling	.127	0.040	.030	.197
Water supply	.030	.020	.025	.075
Total	0.197	0.060	0.115	0.372

Table 5.--Distributions of labor and power at the Placer concentrator for 10 months of 1930

Labor:	(man-hours per ton)	
Superintendence		0.020
Trucking		.039
Shoveling		.020
Grizzlymen		.015
Screening		.020
Conveying		.006
Jigging		.062
Tabling		.018
Dewatering		.012
Maintenance		.020
Pumping		.042
Magnetic separation and sacking		.008
Total		0.282
Average ore treated per 8-hour man-shift	tons	28.4
Power:	(kw.-h. per ton of ore mined and milled)	
Conveying		0.995
Screening		.315
Jigging		.103
Tabling		.103
Dewatering		.370
Pumping		.103
Water supply		1.047
Magnetic separation		.021
Total		3.057
Supplies	per cent of total cost	30.9
Power	do.	16.1
Labor	do.	53.0
Total		100.0

Generated on 2024-09-17 10:03 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

Table 6.—Summary of direct costs at the Union concentrator, 1929

	Dollars per ton of ore milled			
	Labor	Power	Supplies	Totals
Loading and hauling	-	-	-	[1]0.381
Milling	0.458	0.123	0.163	.744
Water supply	.033	.046	.020	.099
Total	0.491	0.169	0.183	1.224

1 - Loading and hauling were done on contract at rates varying from $0.30 to $0.50 per ton, depending on the distance of haul.

Table 7.—Distributions of labor and power at the Union concentrator, 1929

Labor:	(man-hours per ton)	
Superintendence		0.046
Hoisting		.092
Crushing		.086
Grizzlymen		.043
Sorting		.046
Jigging		.074
Tabling		.049
Dewatering		.025
Pumping		.025
Maintenance		.077
Magnetic separation and sacking		.025
Total		0.588
Average ore treated per 8-hour man-shift	tons	13.6
Power:	(kw.-h. per ton ore milled)	
Conveying		1.395
Crushing		3.348
Hoisting		.558
Screening		.186
Tabling		.558
Jigging		.558
Dewatering		.279
Pumping and water supply		2.325
Magnetic separation		.093
Total		9.300
Supplies	per cent of total cost	21.7[1]
Power	do.	20.0[1]
Labor	do.	58.3[1]
Total		100.0

1 - Does not include cost of loading and hauling given in Table 6.

Generated on 2024-09-17 10:01 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

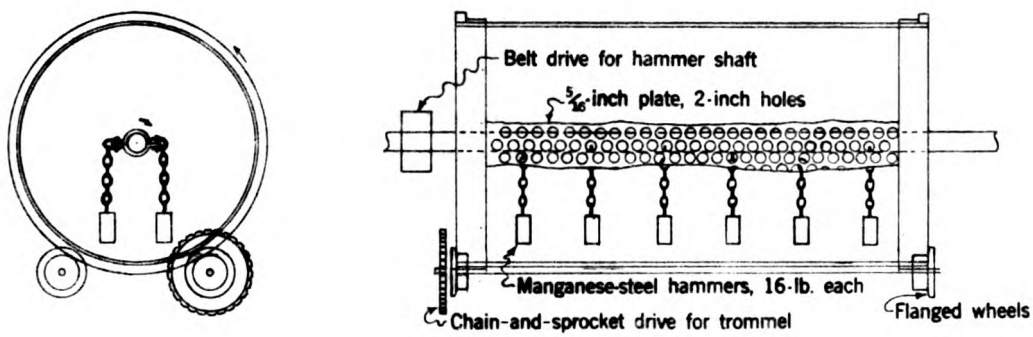

Figure 2.—Disintegrator

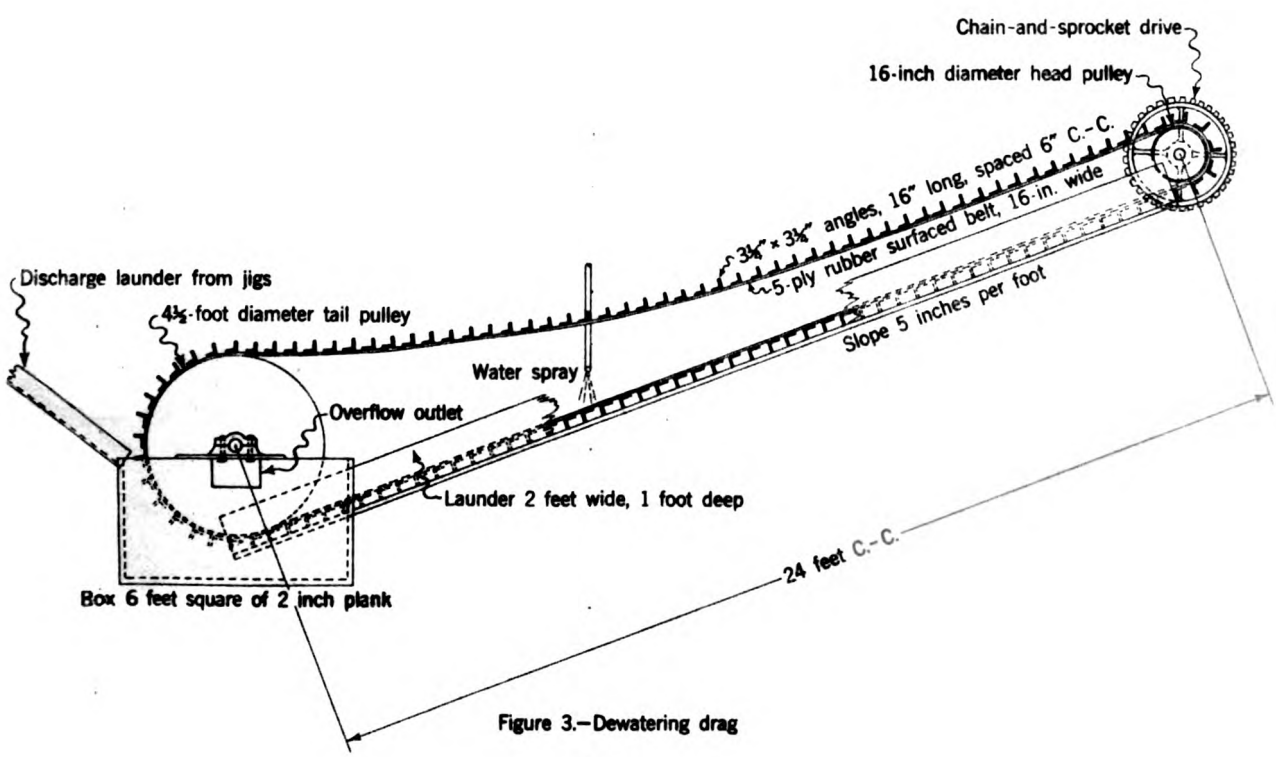
Chain-and-sprocket drive
16-inch diameter head pulley
3¼" x 3½" angles, 16" long, spaced 6" C.-C.
5-ply rubber surfaced belt, 16-in. wide
Slope 5 inches per foot
Discharge launder from jigs
4½-foot diameter tail pulley
Water spray
Overflow outlet
Launder 2 feet wide, 1 foot deep
Box 6 feet square of 2 inch plank
24 feet C.-C.

Figure 3.—Dewatering drag

Generated on 2024-09-17 10:03 GMT / https://hdl.handle.net/2027/osu.32435030644181
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY